GRAINGER

The Construction of the
Illinois Telephone Tunnel

Civil Engineering

B. S.

1911

UNIV. OF
ILLINOIS
LIBRARY

UNIVERSITY OF ILLINOIS
LIBRARY

Class 1911
Book G76
Volume

1022
57

THE CONSTRUCTION OF THE ILLINOIS TELEPHONE TUNNEL

BY

CHARLES WARREN GRAINGER

THESIS

FOR THE

DEGREE OF

BACHELOR OF SCIENCE

IN

CIVIL ENGINEERING

IN THE

COLLEGE OF ENGINEERING

UNIVERSITY OF ILLINOIS

1911

1911
G76

1911
G76

UNIVERSITY OF ILLINOIS

May 25, 1911

I recommend that the thesis prepared under my supervision by CHARLES WARREN GRAINGER entitled The Construction of the Illinois Telephone Tunnel be approved as fulfilling this part of the requirements for the degree of Bachelor of Science in Civil Engineering.

John P. Brooks
Assoc. Professor of Civil Engineering.

Recommendation approved:

Ira O. Baker
Head of the Department of Civil Engineering.

197619

UIUC

THE ILLINOIS TELEPHONE TUNNEL.

Contents.

Chapter I- Introduction.

- Article 1. History.
- Article 2. Location.
- Article 3. Reasons Leading to Construction.

Chapter II- Construction.

- Article 1. Shafts.
- Article 2. Straight Tunnel.
  - a) Air Tunnel.
  - b) Open Tunnel.
- Article 3. Intersections.
  - a) Three Ways.
  - b) Four Ways.
- Article 4. Finishing.
  - a) Track.
  - b) Trolley.
  - c) Motors.
- Article 5. Engineering Work.

Chapter III- Uses of Tunnel.

- Article 1. Disposal Station.
- Article 2. Connections.
  - a) Building Connections.
  - b) Depots.
  - c) Foundations.

Digitized by the Internet Archive
in 2016

https://archive.org/details/constructionofil00grai

Article 3. Illinois Tunnel as connected with future plans for a subway.

Chapter IV- Summary.

Article 1. Totals.

- a) Number Miles of Tunnel Completed.
- b) Number of Intersections.
- c) Pumping Capacity.

Article 2. Costs.

- a) Straight tunnel and intersections.
- b) Elevator equipment.

CHAPTER I- INTRODUCTION.

ARTICLE I- History. The original plans, as given out by the Illinois Telephone Company, and granted by the City Council was to build a tunnel under the streets and alleys of the City of Chicago, of sufficient bore to permit the carrying of wire cables to supply one hundred thousand telephones. Evidently the promoters of the enterprise had in mind a freight proposition, where they made the tunnel of the size considerably larger than would be necessary for carrying their telephone wires.

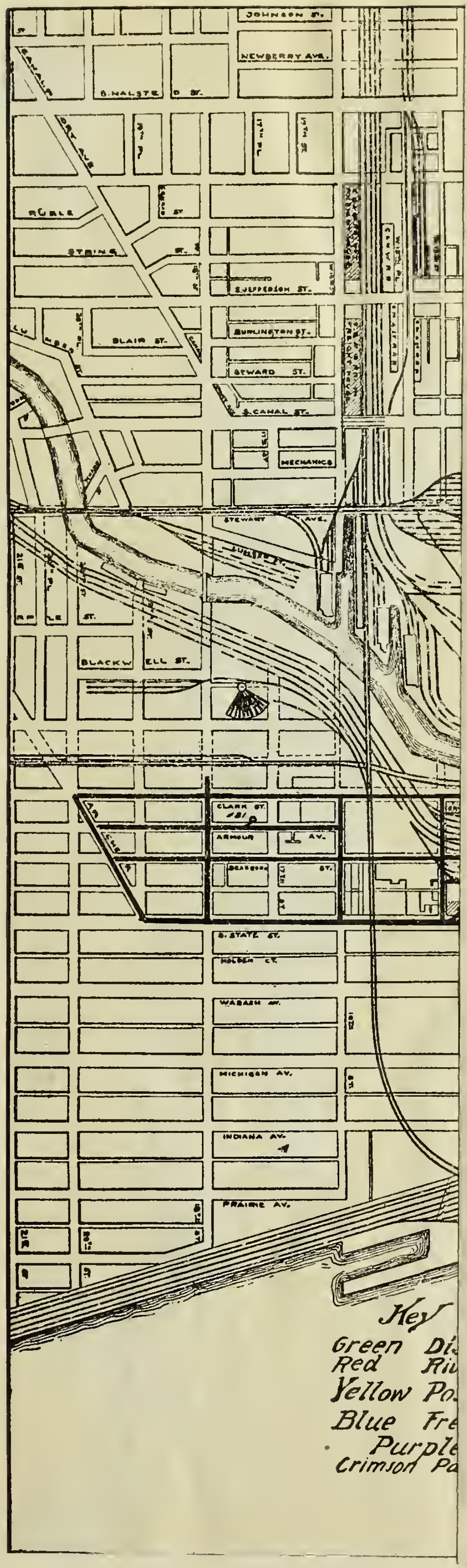
Active work on excavation was started September 1st., 1901, but before long it was necessary to halt until an accurate map of the City streets could be prepared, since none existed. The surveys for this map was undertaken by the Telephone Company's engineers, under the direction of Mr. Alfred Slade, and after completion were checked by the City officials.. Work of construction was then ready to proceed. The city authorities upon being notified of this fact, however, informed the company that work could not be allowed to proceed under the terms of the original permit.

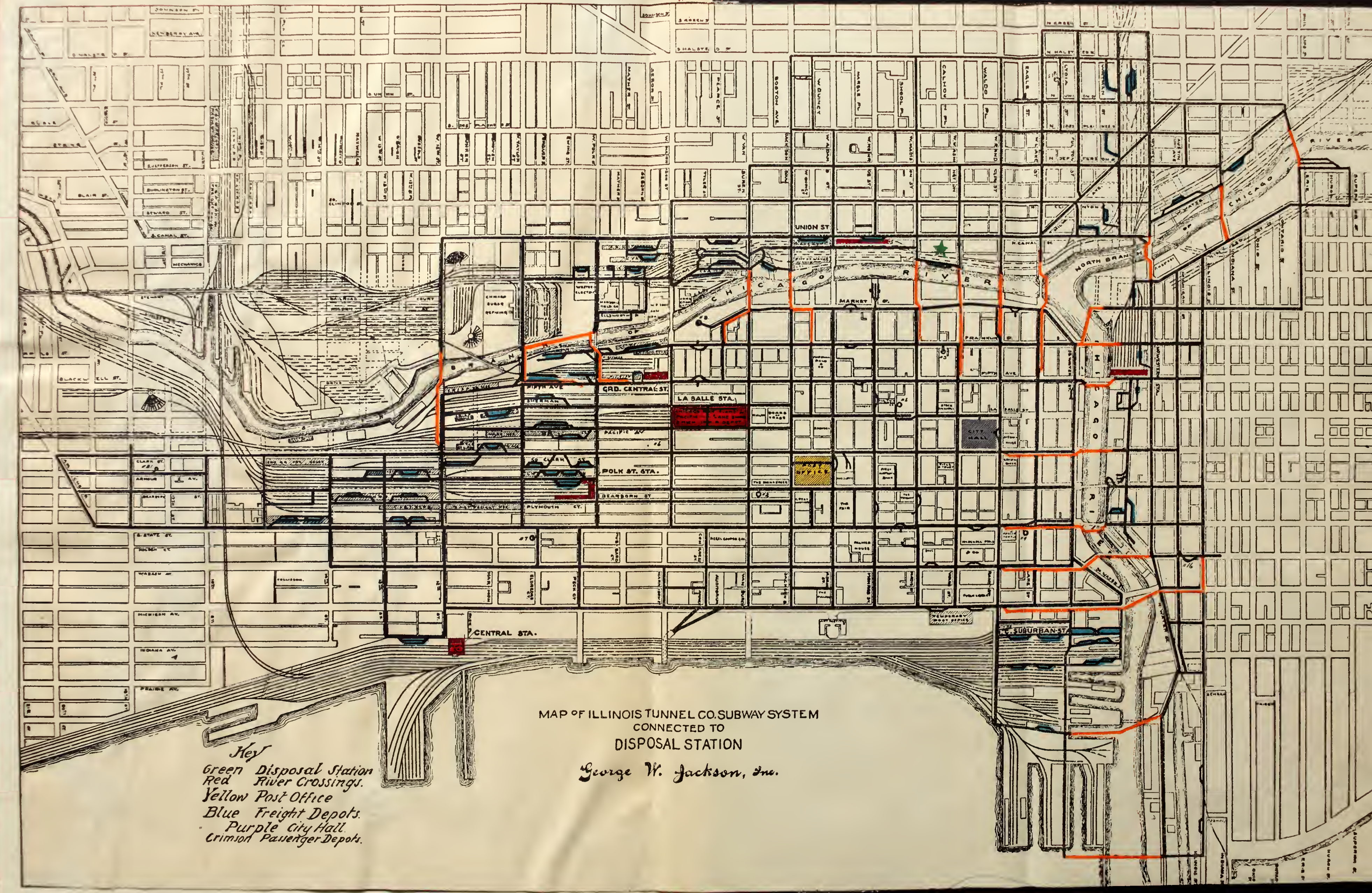
The reasons for this decision were, that the original plan called for a series of man-holes connecting the tunnels at intervals with the street surface, and that the minimum depth of 22 feet, 6 inches below the street surface was too little. Both the man-holes and the shallow depth of the work, it was considered, would be obstructions to an underground railway,

which it was thought the city would some day build. Final plans for the down town district called for a system of trunk and lateral conduits. In cross section the trunk conduits were 12 feet 9 inches wide and 14 feet high, and the lateral conduits were 6½ feet wide and 7 feet high. The minimum depth between the street surface and the topmost part of any of the conduit structure was set at 24 feet 6 inches. Only about 100 feet of the large bore was ever constructed, as in July 1903 the Telephone Company succeeded in having an ordinance passed through the City Council permitting them to make certain changes in their tunnel which would permit them to handle freight.

ARTICLE 2- The conduits of the Illinois Telephone Company are under all the streets and alleys of the business district of Chicago. From the accompanying map, it may be seen that the conduits ran as far south as Archer Avenue, north to Superior Street, west to Green Street and east on both sides of the Chicago River to the lake.

(See map on following page.)


JOHNSON ST.
NEWBERRY AVE.
S. HALSTED ST.
NOBLE
STRING ST.
JEFFERSON ST.
BURLINGTON ST.
BLAIR ST.
SEWARD ST.
S. CANAL ST.
MECHANICS
STEWART AVE.
BLACKWELL ST.
CLARK ST.
#81
ARMOUR AV.
DEARBORN ST.
S. STATE ST.
HOLDEN CT.
WABASH AV.
MICHIGAN AV.
INDIANA AV.
PRAIRIE AV.
Key
Green Di
Red Riv
Yellow Po
Blue Fre
Purple
Crimson Pa



MAP OF ILLINOIS TUNNEL CO. SUBWAY SYSTEM
CONNECTED TO
DISPOSAL STATION

George W. Jackson, Inc.

Key

Green	Disposal Station
Red	River Crossings.
Yellow	Post Office
Blue	Freight Depots.
Purple	City Hall
Crimson	Passenger Depots.

ARTICLE 3- The reasons leading up to the construction of the tunnel are as follows:-

1. To carry surface wires of the company.
2. To carry city police and fire alarm wires.
3. To carry mail between the Chicago postoffice and the railway depots.
4. To carry newspapers from the various publication houses to the depots.
5. To carry eventually all other telephone and telegraph wires.
6. To transport freight.
7. To carry coal from the coal yards of the various depots to buildings within the Loop District.
8. To handle refuse and ashes from the Loop buildings.

One of the main ideas in constructing a subway of this kind, is to get teaming off the streets of the business district, which only covers one and one quarter square miles. The following views show the kind of traffic which is a great nuisance in the business streets.

Figure I, shows the streets covered with an immense amount of snow. This could have been removed from the streets much quicker by having connections with the tunnel and would also have done away with a great deal of teaming.

(See following page.)

Figure II, shows a quite common scene, where a foundation is being dug and the waste being carried away by teams, and Figure III, shows the often common result.

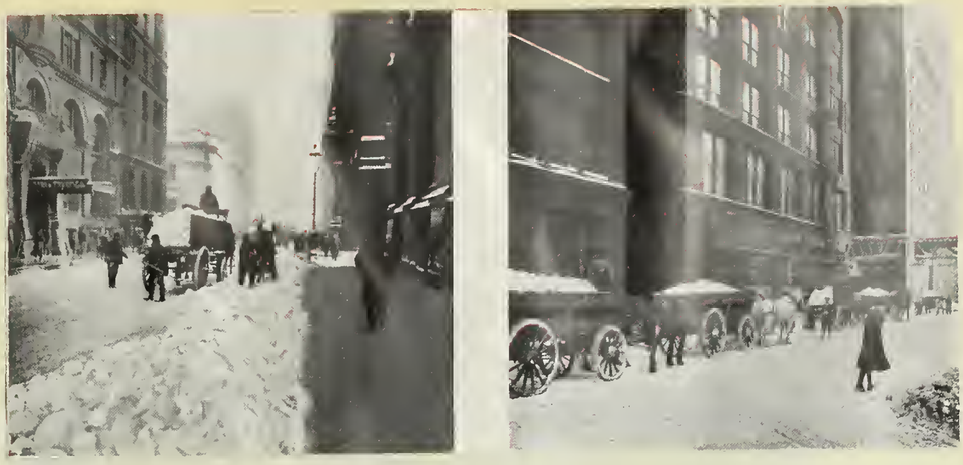


Fig I

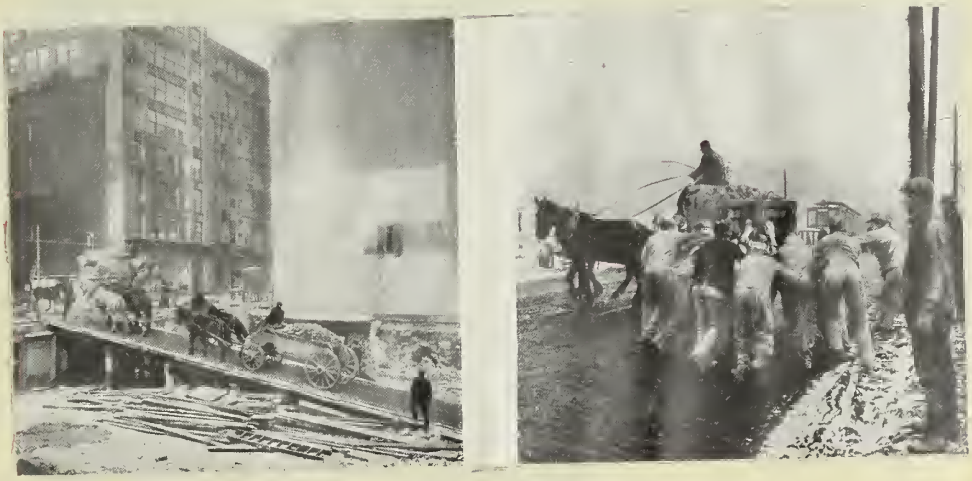


Fig II

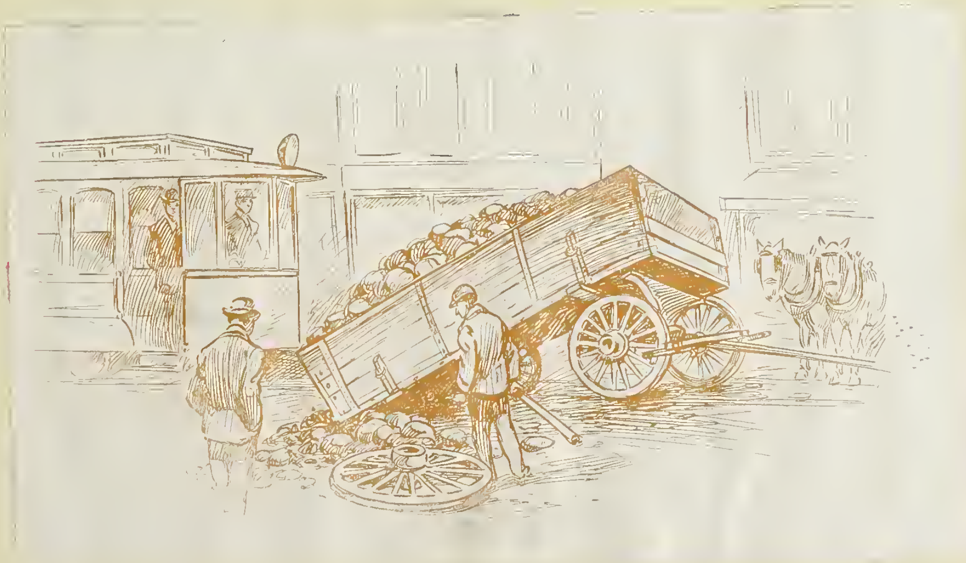


Fig III

Figure IV, shows how the last may be avoided, the cross indicating a connection with the Illinois Tunnel.

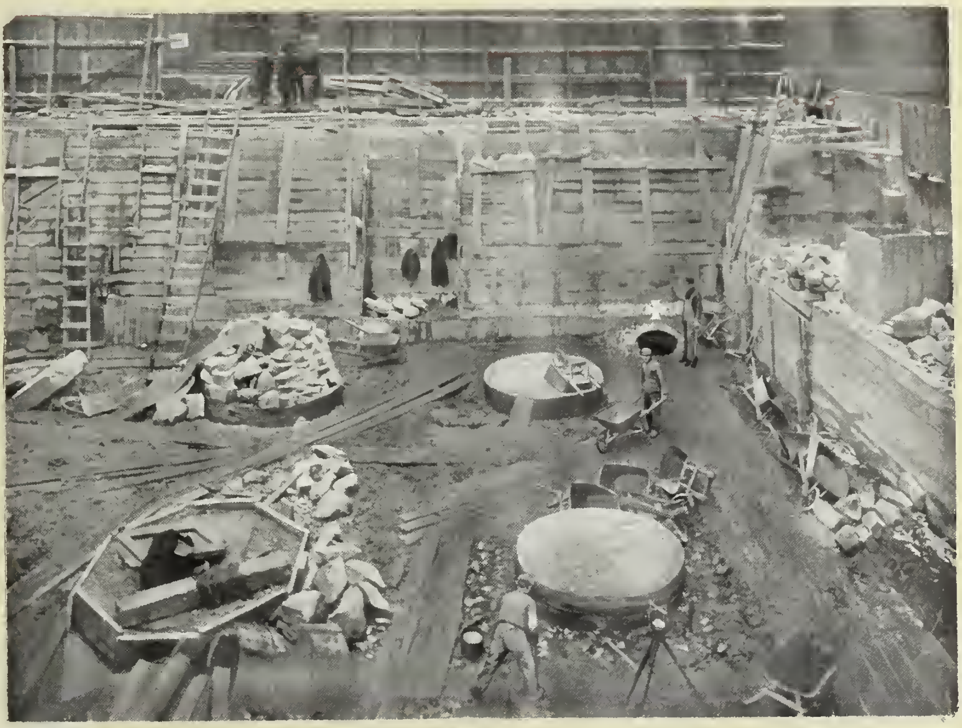


Fig IV

Figure V, shows a very common and at the same time dangerous condition. By having a connection with the Tunnel the coal may be obtained direct from the yards through the tunnel and at the same time furnish a means for disposing of ashes and office waste material.

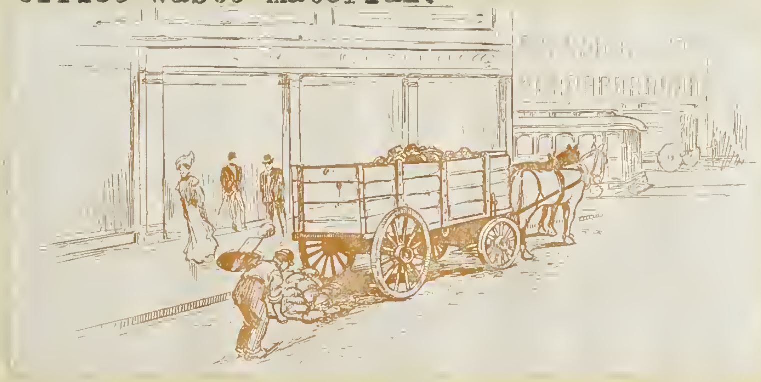


Fig V

CHAPTER II--CONSTRUCTION.

ARTICLE 1- Shafts. The shafts are divided into two groups, 1st the shafts used for construction work of the tunnel and 2nd the freight shafts. I will first consider the shafts built simply for the purpose of constructing the tunnel.

MATERIALS PENETRATED:- The subsoil underlying the down town district of Chicago consists of about 10½ feet of filling, then 18 inches of yellow loam carrying considerable water, then of about 5 feet of soft clay, and finally hard clay increasing in firmness with the depth. The conduit tunnels were entirely in the hard clay which stood up well under excavation.

In the early history of the tunnel, there were several different kinds of shafts used. Shaft I, at the main office, 177 Monroe Avenue was the first one sunk. The shaft was not long used for elevating the spoil as, soon after this one was completed, seven more were started in basements in different parts of the city. The spoil from the tunnel was loaded in small cars which were hauled to the shaft and raised on an elevator to the basement level, or to a head house where they were unloaded into wagons which carried the spoil to the Lake Front or to scows on the river. These empty cars now, if the excavations were completed in the tunnel, would be filled with concrete and run into the headings, so in the basement containing the shaft, arrangements had to be made for emptying the cars and also for mixing concrete.

Shaft No. 8 was the only exception to the above rule,

and I will now explain the different methods of handling the spoil. This shaft was located close to the bank of the Chicago River at the south end of Market Street, where also the company's warehouse is located. Here an incline was constructed from the tunnel to the street surface, up which cars were hauled by an endless chain with a hook which took hold of the axles. The cars were then run onto a fan shaped system of tracks leading to dumping platforms.. These platforms were hinged to the edge of the wharf and provided with gallows frames by which they could be raised and lowered. When lowered the gallows overhung a scow moored along side the wharf, and when raised they left the channel clear. This method was found to be very economical and convenient. There was a concrete mixer in the basement, which was operated by an electric dynamo, and these cars would be loaded with concrete when it was required below, and then be hauled down the incline by the endless chain.

Some of the shafts were simply borings of about 5 feet diameter which ran from the basement floor to the tunnel top at an angle with the vertical of from 30° to 68°. First a rod was driven through to get the proper alignment and then the shaft was excavated to the proper size in sections of about 4 feet, and steel lagging was put in these sections and bolted together. In one side of the tube a stair way was put in and in the other, a concrete chute. These of course, were only temporary shafts. The permanent shafts were constructed as follows:- First the shaft was staked out, and then steel interlocking sheeting of a

length sufficient to reach to the top of the conduit was driven. This sheeting was only about 6 inches wide and not very heavy so that a large driver was not necessary. Usually a driver rigged up on a windlass was sufficient, especially as excavation was carried down with the sheeting. In many cases water was encountered, and pumps had to be carried down along with the excavation. As soon as the excavation was down, concrete forms composed of segmentals steel sheeting, was put in place and the shaft was then concreted. After the concrete had set seven days the concrete forms were removed and the elevator machinery installed.

Another method of sinking shafts is as follows:- A steel caisson was used, made of No. 12 steel plates with a 3 inch angle iron riveted to the plate at the top and bottom. These steel plates were made in sections 18 inches deep and divided into proper lengths to fit a semicircle 9 feet in diameter as shown in Plate I. The sections of steel plates and lagging were bolted together as the excavation was being done, or, in other words, the depth of the section being 18 inches. Only about 18 inches in depth at one time were excavated, which excavation allowed the placing of one of the sections and fastening it to a completed upper section. After the shafts had been sunk to a proper depth, a 7 inch wall of concrete was constructed inside the caisson..

Plate II, shows a cross section of a shaft and the reinforcing bars.

Figure VI, shows a view of a shaft with the observation car upon it.

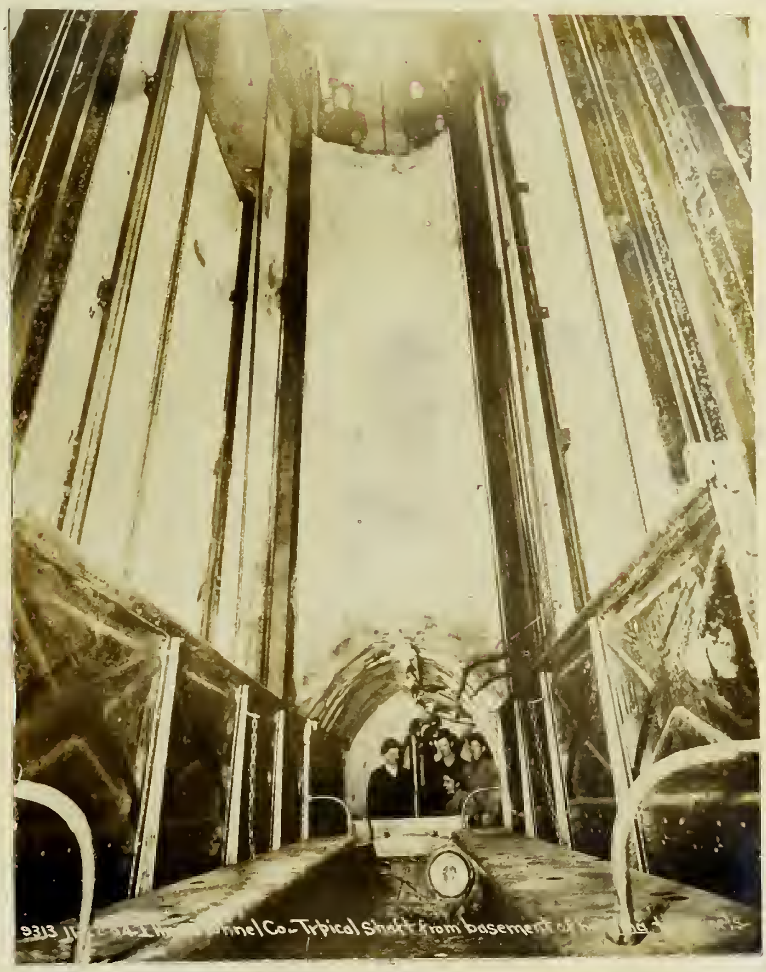


Fig VI

ARTICLE 2- Straight Tunnel. It was decided that the best and safest way of carrying on the work would be the pneumatic system. Although it was not altogether necessary to use compressed air, the nature of the soil to be penetrated was such that it would stand without swelling or caving, but the pneumatic system was installed more as a safety against labor troubles than for any other reason. With that system, if the men should go on a

strike there would be no danger if the work was left for a time in an uncompleted state.

In installing the pneumatic system, airlocks were placed just outside the several shafts. These airlocks have iron doors with frames embedded in the concrete, the locks being as long as considered necessary, in some cases accommodating as many as ten cars. Two air tight doors were used, one at each end of the lock. The "locking in" process is affected by allowing the cars to enter through the open door, then the door is closed. The air under pressure is then admitted from the uncompleted tunnel allowing it to flow into the lock; thus equalizing the pressure in the lock with that in the tunnel. The inner door is then opened and the cars are run to the headings. The same process is reversed in "locking out."

Figure VII, shows a cross section view of the tunnel, with all dimensions. The tunnel constructed under air pressure is worked generally, by two shifts of men. One shift coming on at midnight and excavating, and the other shift coming on at 8 o'clock in the morning and concreting what the night men excavated. If the ground is hard though, and grubbing is necessary, there is generally two excavating shifts, the first one coming on at four in the afternoon.

(See following page.)

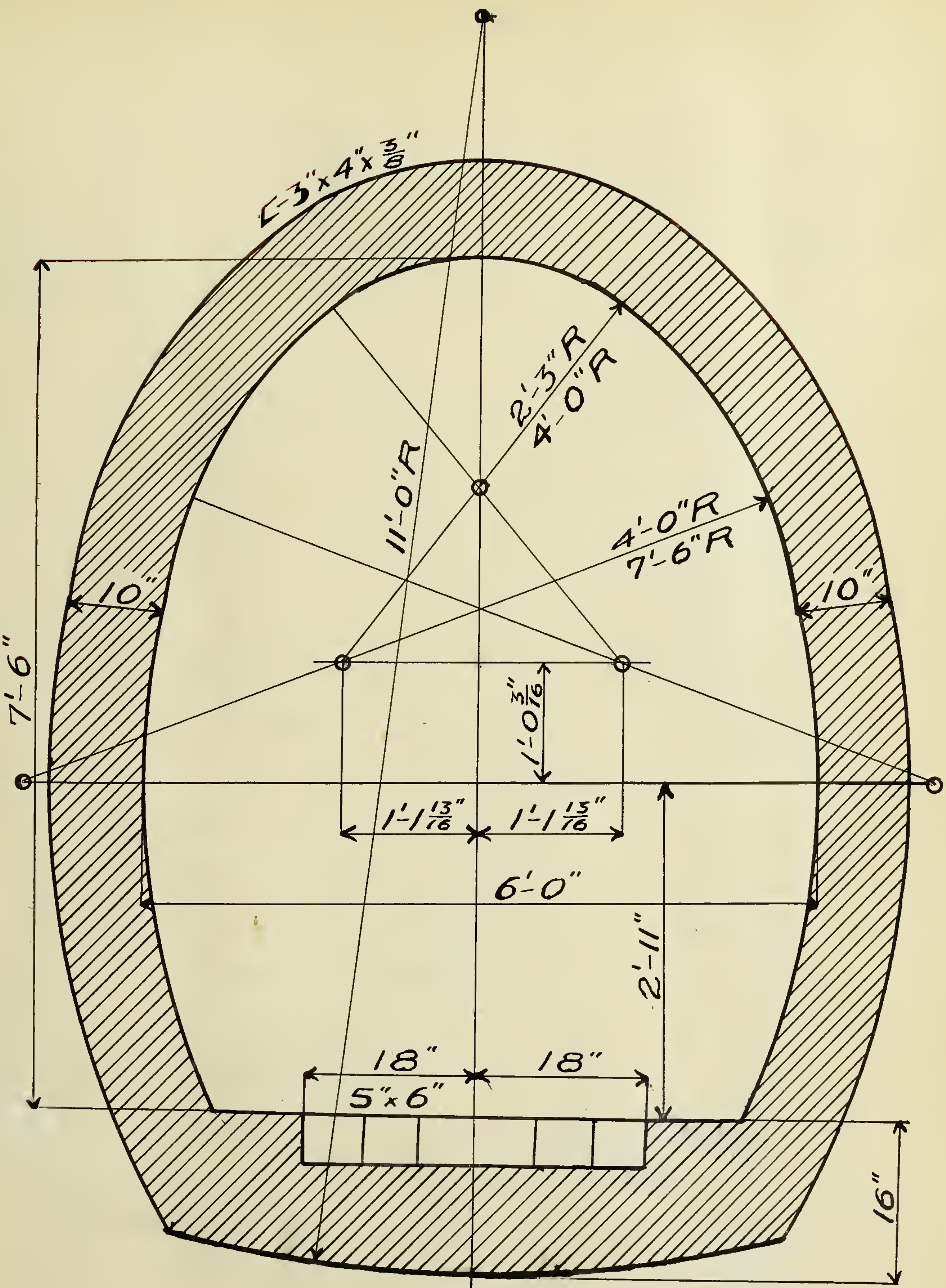

⊏-3"x4"x3/8"
2'-3"R
4'-0"R
11'-0"R
4'-0"R
7'-6"R
10"
10"
7'-6"
1'-0 3/16"
1'-1 13/16"
1'-1 15/16"
6'-0"
2'-11"
18"
18"
5"x6"
16"

Fig VII

Generally a linear distance of 12 feet was opened up at a time. Where the material penetrated was fairly soft clay as most of it was, the excavation was carried on by means of the two handled knife shown in Figure VIII.

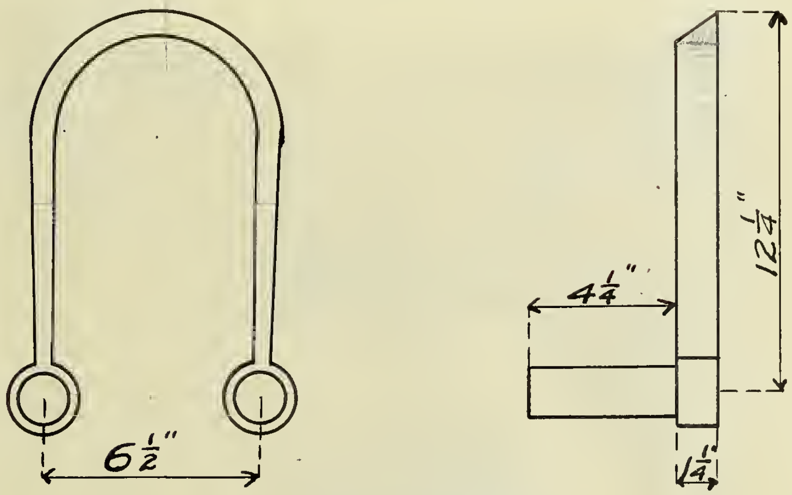


Fig VIII

Figure IX, shows an open cut after excavation, and I will now explain the operation. An opening is made straight ahead from the concreted section, and then it is expanded on the sides to the proper size. Two miners take the handles of the cutting knife and reach up as high as they can. A mucker takes hold of the miner's shoulders and they all pull down together to as low as they can reach. The mucker then catches the material ripped out and throws it behind him to another mucker who loads it into the cars. After they have excavated it to a proper size down to the floor and for a distance of about 12 feet, the part beneath the floor is dug out with shovels. A car-pusher pushes the cars out to a connection where a skinner with his mule takes them to the lock, where they are "locked out." The small cars are then

run up on a platform where two laborers unload them into the larger cars on the main track. Working one heading requires the following men:- two miners, two muckers, one car-pusher, one lock tender, and two laborers. Where there is more than one heading being worked from an airlock, one skinner can handle about two headings.

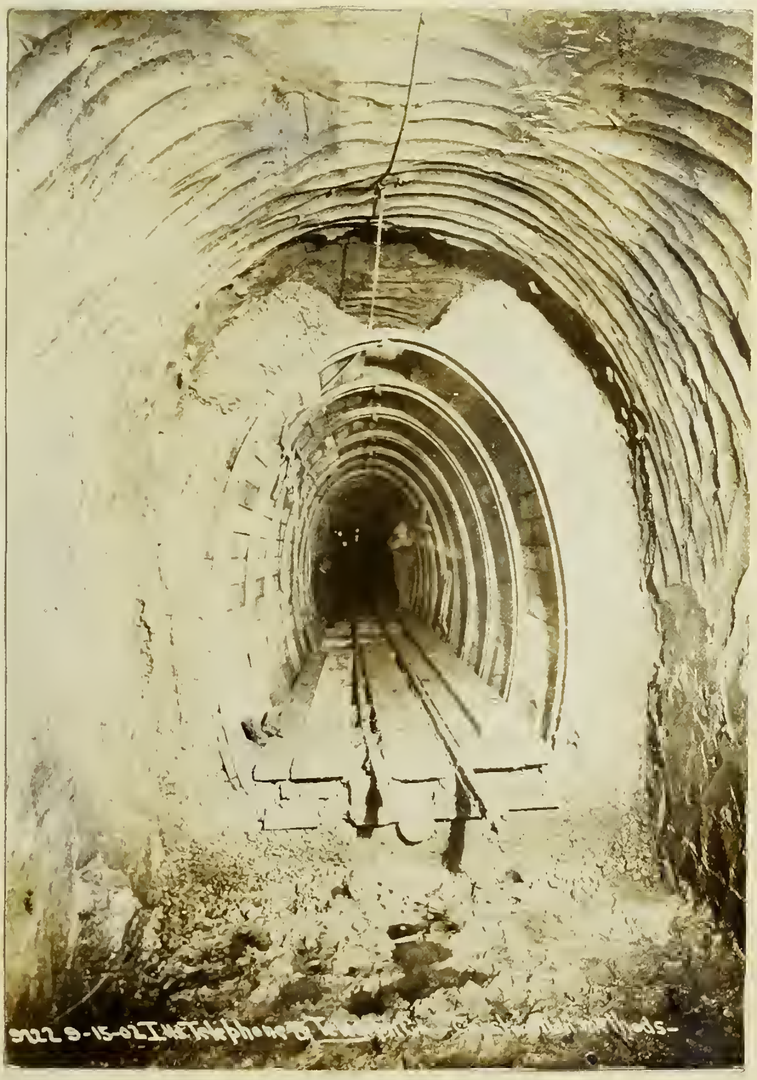


Fig IX

When the concreting gang first go in in the morning, they generally busy themselves by laying flooring and the small rails in the section last concreted, as shown in Figure IX, and

in getting their forms ready. The engineers get down as early as possible in the morning, and give them grade and line so if any trimming is necessary they can be doing it while waiting for concrete. The actual size of the excavation is not less than 9 feet 8 inches high and 7 feet 8 inches wide at the widest part. It takes about twelve cars of concrete for the bottom.. All headings are supplied with this amount as soon as possible. About 6 inches of concrete is put in, and then a 2 inch by 6 inch lagging $2\frac{1}{2}$ feet long is placed 12 feet from the last set form, and a 2 foot by 6 foot lagging placed along the sides, forming a box as shown in Figure X. Then concrete is put in up to the level of the lagging and 2 inch flooring is placed above that. The forms which are made of 5 inch 10# steel channels are then brought in and bolted together, and lined up by the engineer. This is done by means of lining the top bolts in by eye with two strings through horse shoe nails with holes in them, placed in the top lagging behind and on the line. Then the forms are braced by driving strips of wood into the clay at about the three quarter point of the forms, and bending the strips over to the forms.. The forms are spaced three feet apart and are held together by means of a strip of lagging 2 inches by 6 inches by 6 feet long, fastened on each side of the forms and to the last set form. Holes are punched in the forms about 3 feet from the bottom in order to allow this nailing which is not done very strongly. Then a one, three, six mixture of concrete is rammed between the lagging and the excavation, six inches in height filling all

voids before another section of lagging is placed, and so on until the concrete is placed all around except in the key. The crown lagging in the first 6 feet is placed first, and the concrete is thrown in from the second section. Then the lagging is placed in the second section and the concrete is thrown in from the face. This concrete is well rammed by means of pushing the concrete back with a lagging. A space in the key of about 18 inches is left open in order to give a good bond on the next section.

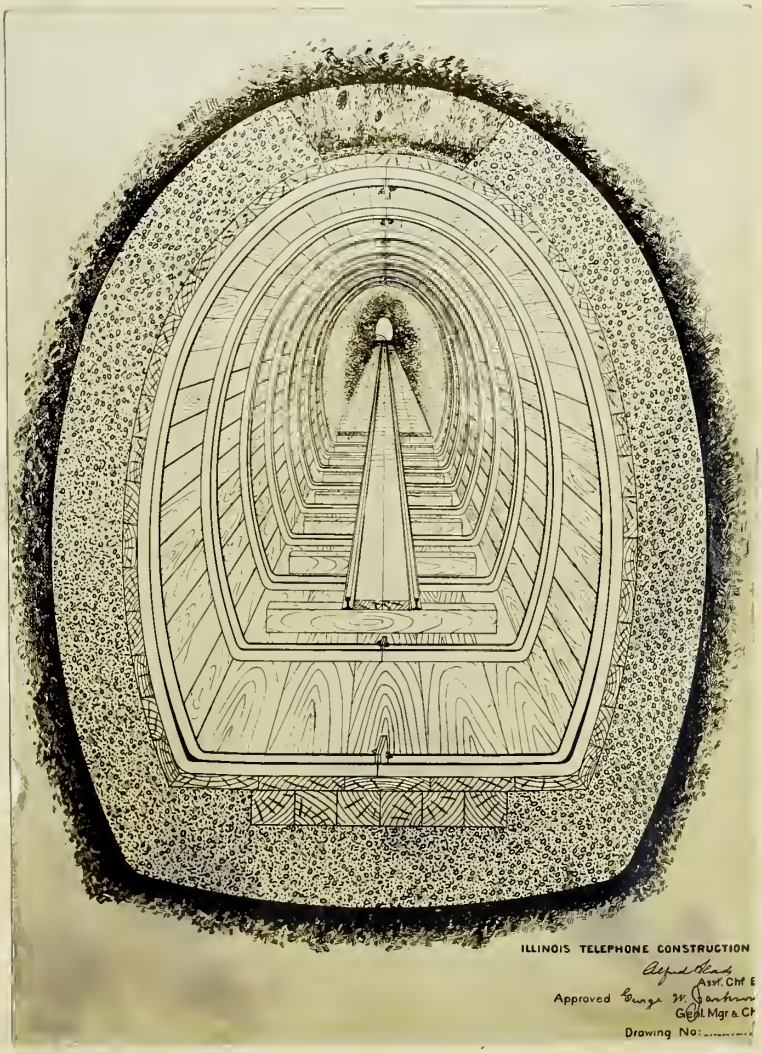


Fig X

After the tunnel is completed to a distance too far for a car-pusher to keep empty cars at the face while excavating, the day gang lays a flooring upon 5 inch by 5 inch timbers laid crosswise between each two forms, upon which 12# rails are laid.. In long hauls from the lock there is a double track supplied with switches and cross overs where necessary. This construction may be plainly seen in Figure X.

There was very little tunnel constructed without air pressure, in fact the only places where it was not used was in small connections after the airlocks had been removed, or in building connections which were put in after the tunnel was finished. A different method has to be used in this case, as without air pressure it would be more or less dangerous to open up 12 feet Consequently only 3 feet was opened up and concreted in a shift, working three shifts a day which made nearly as good progress as the air tunnel. Unless the material was hard and grubbing was necessary, there was only one miner and one mucker, and a car-pusher where necessary, to a heading and where grubbing was necessary, another miner was added. With this forve it would generally take about five hours to excavate and the remaining three hours to concrete it. Often one shift would not finish the concreting and the next shift would have to finish it before starting to mine. The method of construction is the same as for the air tunnel.

ARTICLE III- Intersections. (a) At street intersections where it was only desired to go at right angles and in two directions, a

three way was used. Figures XI and XII show a three way in operation through one branch and a three way plan respectively.

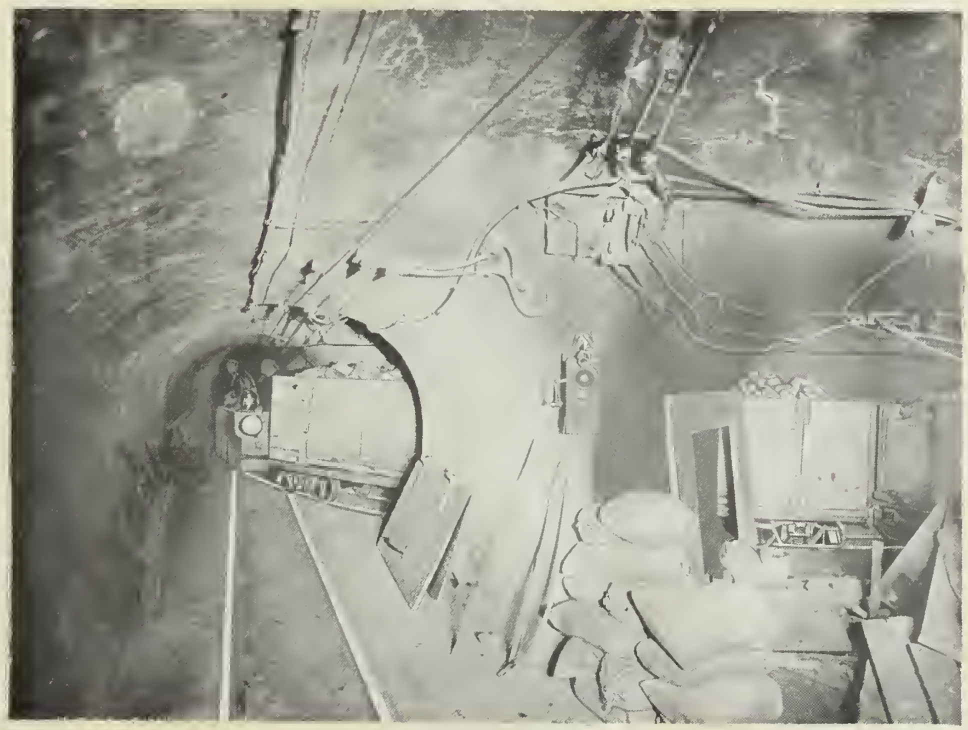


Fig IX

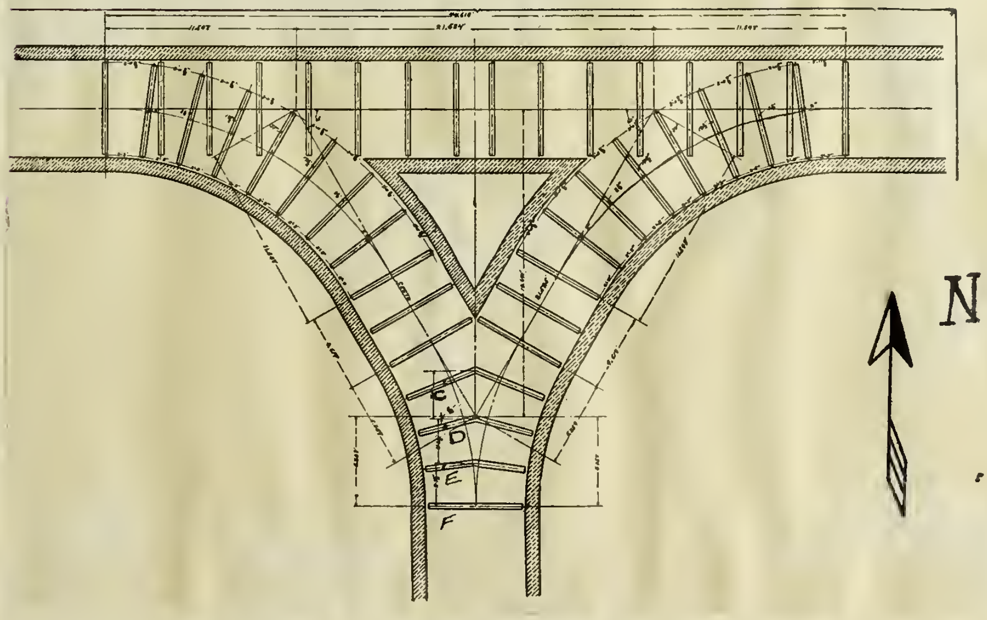


Fig XII

Plate III, shows a working drawing for a three way. The arrow on the plow is simply placed there to aid in the description. In the south branch form F is the regular form. Form E is 4 inches larger than the ordinary form, and the latter is generally used with a 4 inch block between the halves. This makes a distance at the outside of the forms of 2 feet 3 inches, while the centers are 2 feet $7\frac{1}{2}$ inches. The D forms are $16\frac{1}{2}$ inches larger than the ordinary forms. These are spaced 2 feet $8\frac{1}{2}$ inches, from the E forms and 5/16 inches ahead of the center of this form is the point of tangency for the next ten feet on the curve as shown in Plate III. The C form is 35 inches larger than the ordinary form and if this form is not handy, two ordinary forms may be used and the inside sides interlapped enough to make the required size. From the C form on around the curve and on to the tangent the ordinary forms are used with 2 feet 3 inches between the forms on the inside, and 2 feet $11\frac{7}{8}$ inches on the outside. All dimensions are given in Plate III.

(b) Four Ways. Forway Way Connections were used where it was desirous of going in four directions from a street intersection. There was 45° connections between each right angle intersection as is shown by the plan in Figure XIII. (See following page.) Figure XIV, shows a view of a completed four way intersection and Plate VI, at the end is the working drawing for a four way intersection at Kinzie and Clark Streets.

I will described the construction going north on Clark Street, as is detailed in Plate VI. Form E was usually just a plain form

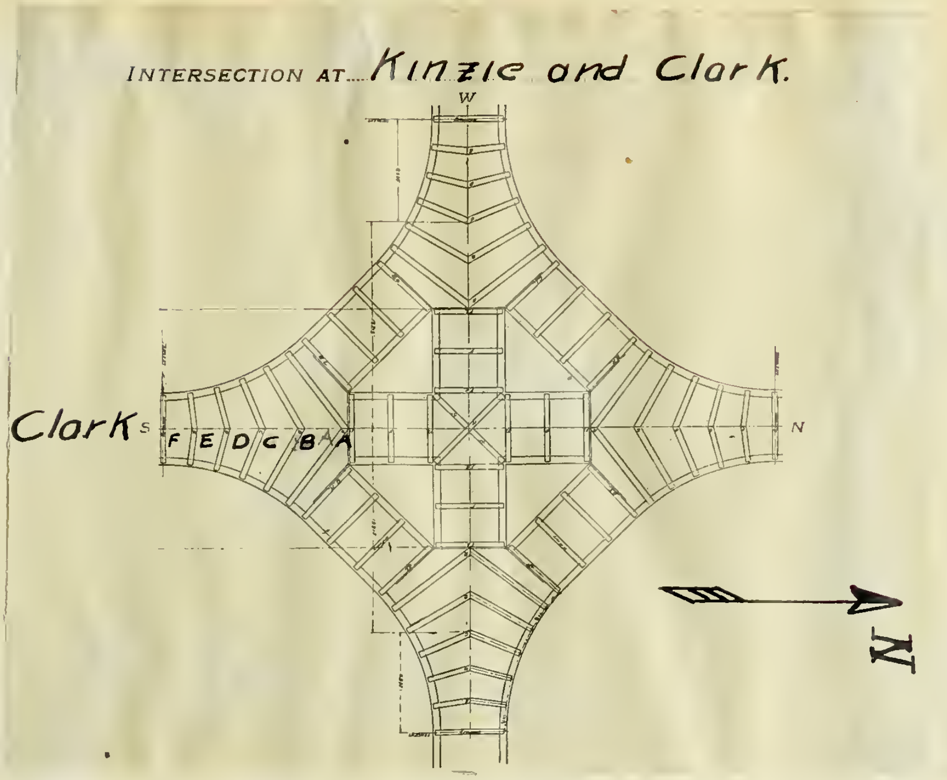


Fig XIII

with a 4 inch block in it, being 27½ inches c. to c. at the center and 26 3/16 inches c. to c. at the outside. The D form was larger than that for the E and could be made by interlapping two complete forms. The C form is made of two halves, each being 4½ feet wide. The intersection slopes upward being 8 feet high at this point. The thickness of concrete is also increased from 10 inches at the P.T. to 18 inches as a maximum at the G.R.;.at the C form it is 15 inches thick. The curve is made by keeping the outside distance from c. to c. of forms constant at 26 3/10 inches, while the center distances are increased. The C form being 2 feet 11 inches ahead of the D form. The B form is spaced 3 feet 3 inches from the C form and is made of two half forms, each being 8 feet wide and 8 feet 9½ inches high, and spaced 3 feet 8 inches from the B form. Section A-A-A-A shows a section of the G. L., F. and G.R. forms. The F form is 8 feet 9½ inches high, and the top of which is con-

nected to the A form. The G.L. and G.R. forms are the ordinary size, 7 feet 6 inches high and are connected at an angle with the F form by steel plates. The outside halves of both the G.L. and G.R. forms may be simply the ordinary kind. The F forms are carried entirely through the straightaway in the intersection, being spaced 3 feet 3½ inches apart and having 16 inches of concrete in the bottom. The same operation is carried on in all four of the tunnels. The total length of the four way intersection is 50 feet 10 inches. From an engineer's stand point, these intersections show the most noteworthy work done in the tunnel. The concrete used in the intersections was composed of four parts gravel and sand mixed, and one part cement.

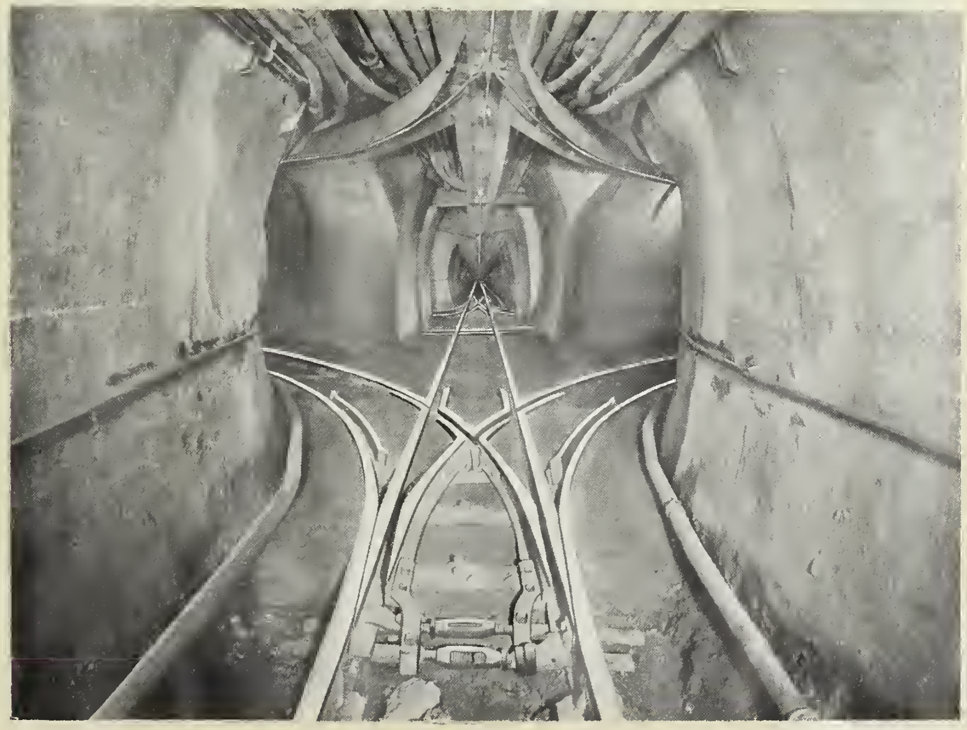
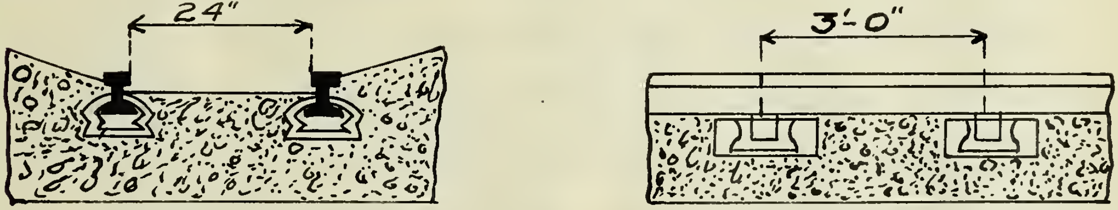


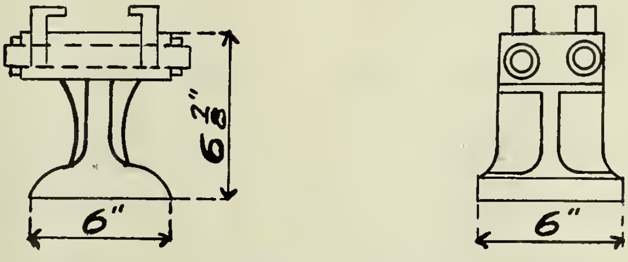
Fig XIV

ARTICLE 4-(a) The permanent track has a gage of 2 feet, and the Illinois Steel Company 4¼ inch $56^{\#}$ was adopted as standard. The rail is fastened by U bolts to a special designed cast iron chair, embedded in the concrete floor of the tunnel. The great number of crosses and switches made necessary by all the street intersections turnouts or by passes leading to the different buildings made it imperative that this part of the track system be as near perfect as possible. The crossings in use are all bolted to steel plates that extend over the entire crossing, and these are embedded in the concrete floor. The switches are of the variety known as the "split" and the frogs are constructed like the right angle crossings. The following sketch shows the rails and connections.



$56^{\#}$ Rails

Cast Iron Shoes



Rail Chair

Fig XV

(b) Except at the incline at the Lake Front, where the Morgan third rail is used, the overhead trolley is used throughout. The third rail consists of a steel strip about one half inch in thickness by 4 inches wide, clamped between insulated wood

stringers, laid lengthwise in the center of the track. The rail furnishes not only the current for the locomotive, but the means of moving the locomotive as well, for it is provided with an opening for cog wheels which are fastened to the car axles.

A 0000 figure 8 trolley wire, adopted as standard is held in place by Porter & Berg's standard barn trolley hangers placed 15 feet on center. There are automatic section insulators and throws used at all street intersections. This enables the current to be cut out in any lock during temporary repairs without shutting off the current from any other part of the system.

(c) On the incline at the Lake Front, it was found advisable to use the Morgan B type of locomotive; while in the tunnel proper there are two types in use, viz: The Jeffrey's Standard M.H.. Locomotive and the General Electrical Standard L.M. locomotive. The weight of the Jeffrey locomotive is six tons and is equipped with two 18 horsepower motors, while the weight of the General Electric locomotive is five tons, and is equipped with 20 horsepower motors. The cars are of a low and compact construction as is seen in the illustration. The cars employed are the Kilbourne and Jacobs and the Bettendorf double track type. The cars are 12 feet 6 inches in length overall, and 47 inches in width. They are of steel and iron construction throughout, and can be used either as gondola or as flat cars, and every car is equipped with the M.C.B. coupler. The weight capacity of the car is 30,000 pounds. In the early days when the construction work was at its height, the box cars were equipped with the Newman patent

pump box which has a capacity of 3½ yards. The cars used for hauling the spoil to the shafts and taking the lining concrete from the shafts to the work, were 20 inches wide and 4 feet long, and were built to run on a 14 inch gage track.

ARTICLE 5. When the work in the tunnel was at its height a good many engineers were employed. There were about 12 shafts being worked at one time and each shaft had an engineer, an instrument man, and from one to three rodmen according to the number of headings being worked. Of course there was not any use for engineers in the night shift when working the air tunnel. The open tunnel required one man on each of the night shifts to give line and grade, set forms, and to see that they had trim enough. The men at night took grade by use of a hand level from the last form set, so no instruments were needed on the night shifts.

The day men reported at eight o'clock in the morning and immediately changed their clothes, getting down in the tunnel as soon as possible. Grade was given in each heading by the level, and the line marked on the clay ahead. The excavation was then measured up and if trimming was necessary, the miners were set right at it. It was generally about noon before the bottoms were all filled up with the concrete and ready for setting the forms, so the engineers would generally go on top for lunch and come down again about one o'clock in the afternoon and set the forms. After the forms were set, if any of the line points were too far apart or an intersection was at hand, instrument work would be done. The points were carried on lagging in

the roof, and points for the transit to set over were plumbed down to a lagging fastened in the flooring. Sights were taken by hanging a plumb bob in the roof points and holding either a candle or an electric light behind them. This instrument work was very difficult at times, as the flooring was not solid and the skinners would want to get past with their concrete. I might add here that it was very dangerous to be in the tunnel without a lantern.

CHAPTER III---THE USES OF THE TUNNEL.

ARTICLE I- Disposal Station. Ths disposal station is located on the west bank of the Chicago River from Madison to Washington Street. It is built on the level of the viaduct on Madison and Washington Streets, and is connected with the tunnel by two shafts. Figure XVI shows the plan of the tunnel to the disposal station and Figure XVII the finished view.

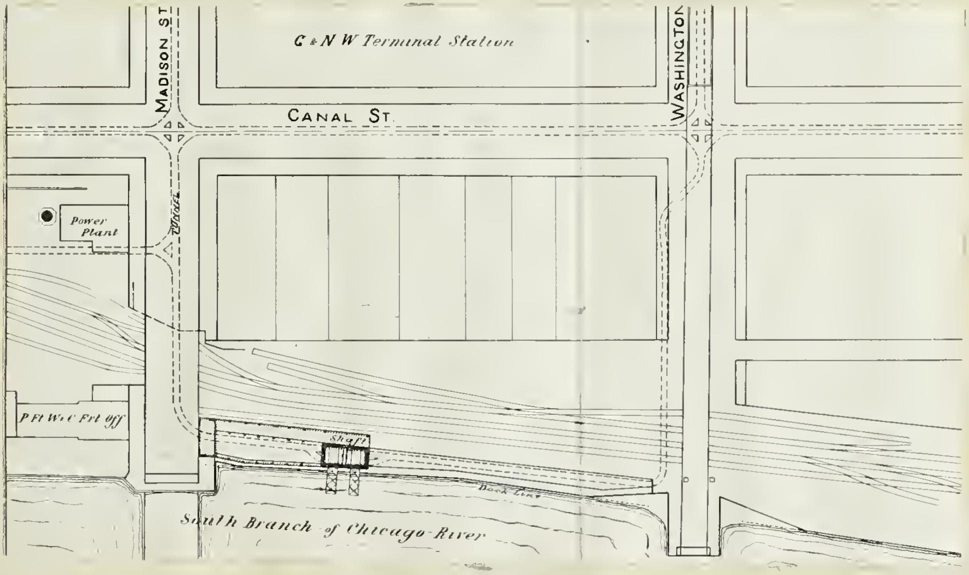
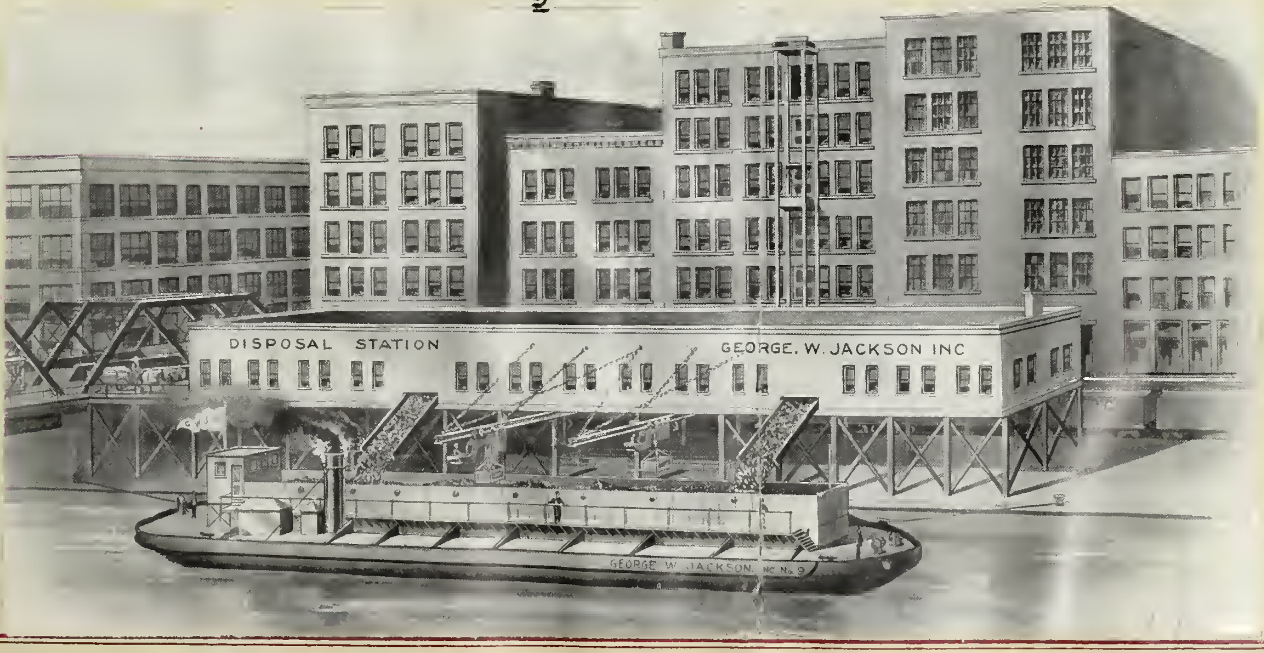


Fig XVI

Fig XVII



The connections with the tunnel enables those who desire to have to have tunnel connections made for the purpose of transporting such material as that from basements, sub-basements, caissons, foundations, tunnels, refuse from buildings, etc, to the station by this method. Driveways from Madison Street allow teams to drive up and get rid of refuse. The character of the scows as is shown in Figure XVII, enables them to work the year around, regardless of weather conditions.

Figure XVIII, shows the excavation for the 15 foot by 30 foot, by 45 foot shaft to make the necessary connection with the tunnel system. The shafts were lowered in the usual way, steel sheeting being driven down first, and not much difficulty was met with. But in the tunnel connections while excavating, a buried pile was encountered and in place of sawing it off, it was hacked with a duel axe and it became loosened with the usual results of water coming in a trickle which rapidly increased. It became beyond control and soon filled both shafts up. Divers were employed and finally a concrete bulkhead was made in the tunnel at the bad spot, the water was finally pumped out and construction was started again.

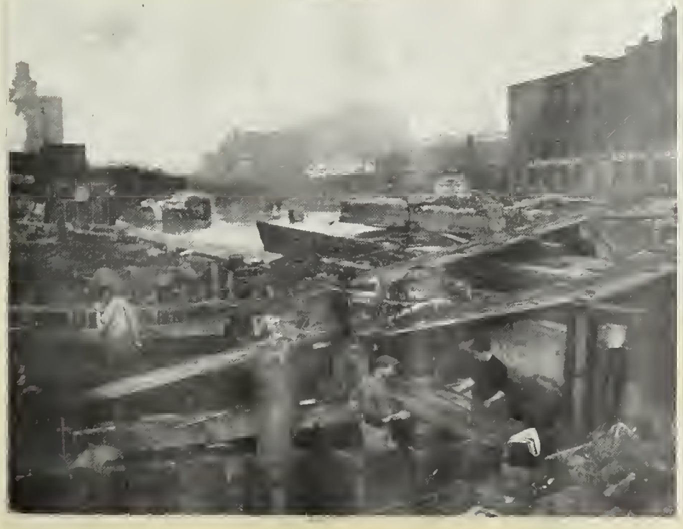
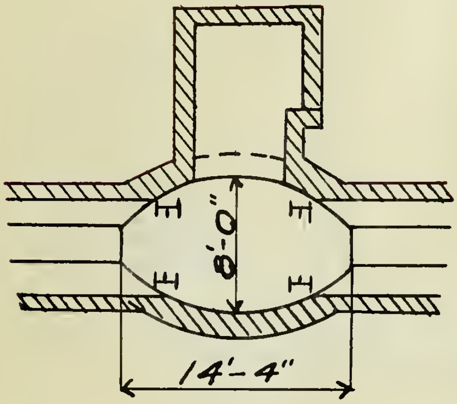
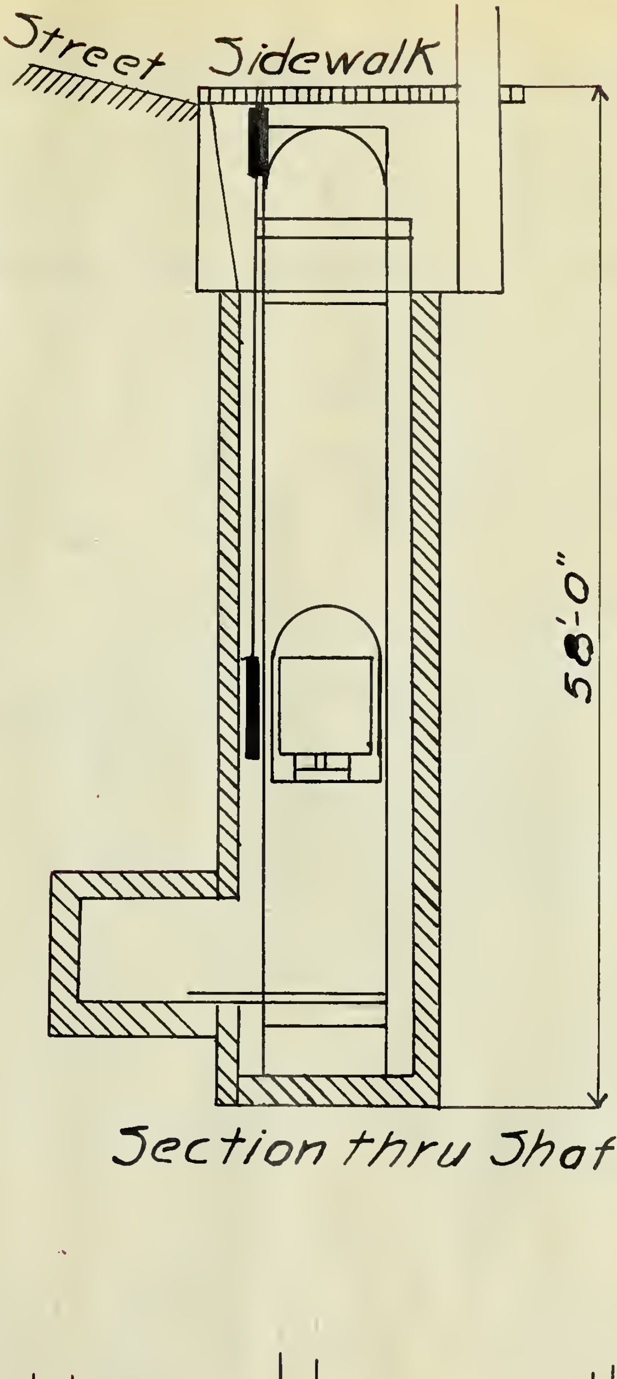


Fig. XVIII





Section thru Shaft

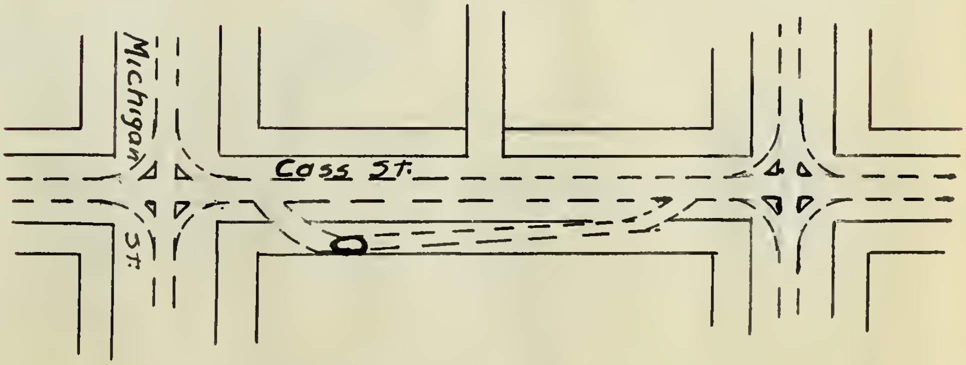


Fig XIX

ARTICLE 2- Connections. (a) The tunnel solves a hard problem for the city, that is- the handling of ashes and refuse from the large buildings. A connection with the tunnel enables the firemen to get rid of the ashes at any time, simply by having a siding under the building with a chute to the tunnel. Figure XIX (See page 27) shows the plan for a standard building connection with a shaft, and Figure XX shows a standard refuse chute in connection with caisson digging. The same chute would be applicable for refuse.

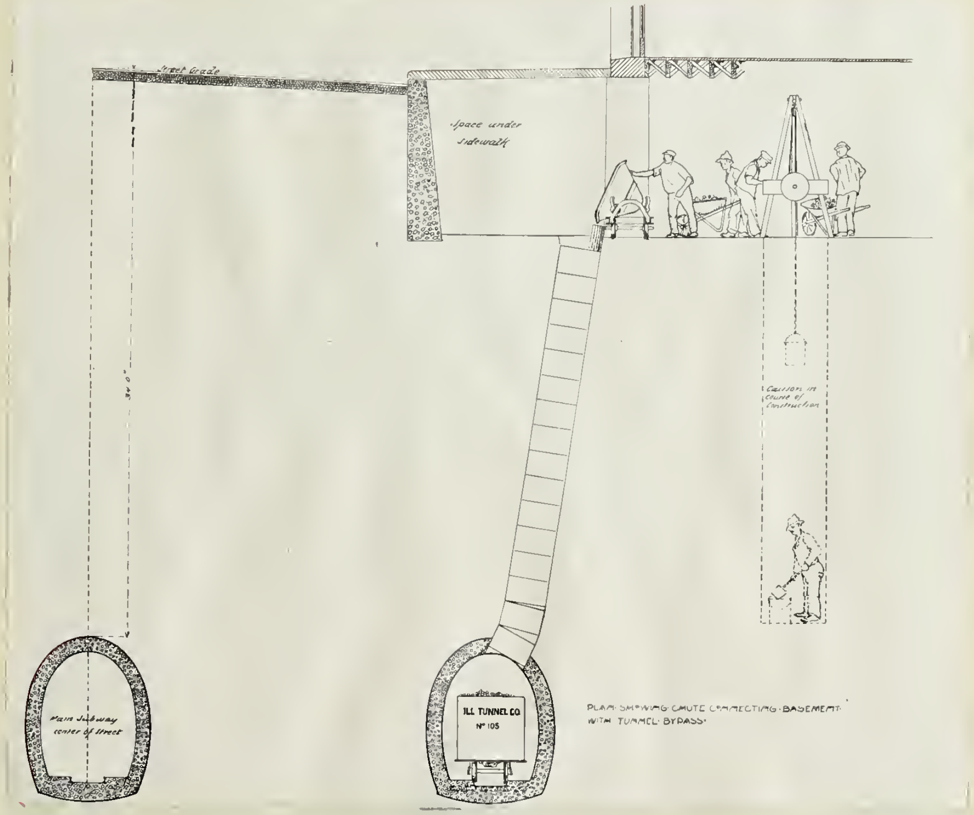

Street Grade
Space under sidewalk
34' 0"
Caisson in course of construction
Main Subway center of street
ILL TUNNEL CO
Nº 105
PLAN· SHOWING· CHUTE CONNECTING· BASEMENT· WITH· TUNNEL· BYPASS·

Fig. XX

Figures XX1 and XXII show the plan of a chute connecting the main tunnel and the tunnel end of the chute respectively. (See following page.).

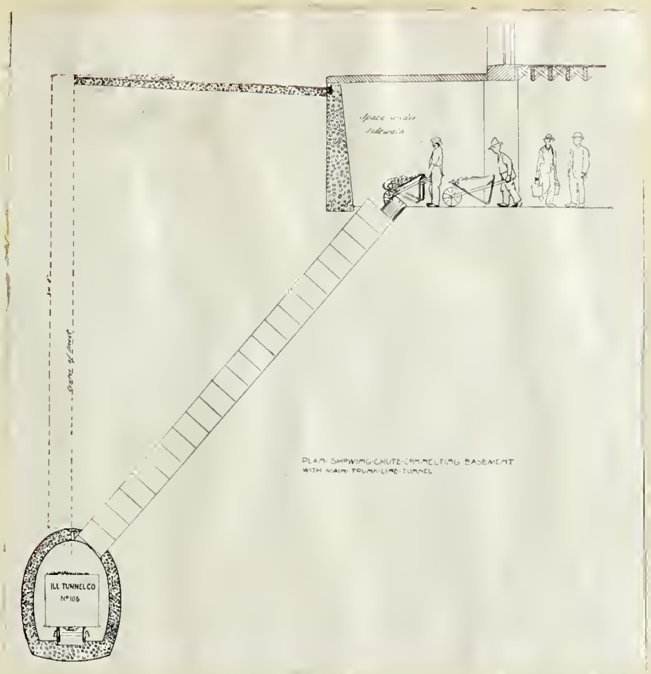

Space under sidewalk
ILL TUNNEL CO
Nº 106
PLAN·SHOWING·CHUTE·CONNECTING·BASEMENT
WITH·MAIN·TRUNK·LINE·TUNNEL

Fig XXI

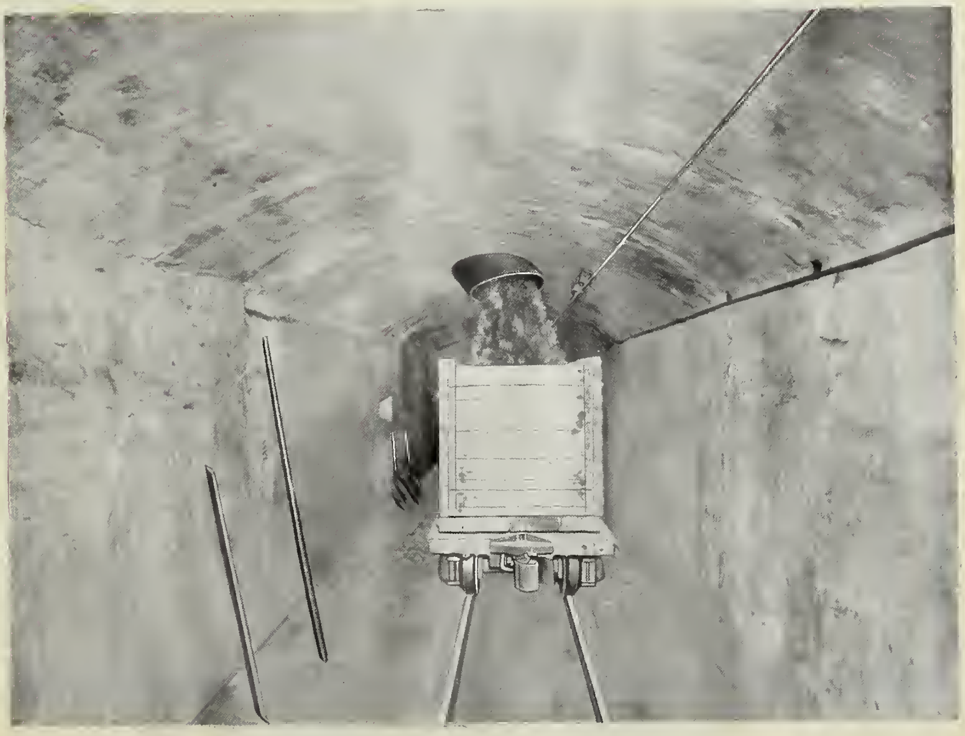


Fig XXII

(b) Depots. Connections are made with all the freight depots of Chicago, and the firms who have connections with the tunnel can get their freight very quickly. The cars will carry anything that can go through a freight car door, so the size of the tunnel is no draw-back in this field. The passenger depots also have connections through which mail comes from the post office. This is a double advantage, as they can get the mail through the tunnel, barring accidents, much quicker tham by wagon, and this also takes quite a bit of traffic off the streets..

(c) Foundations. The advantages of the tunnel for building foundations is best illustrated by an actual case. The excavation for the caissons and a four floor sub-basement for the Steele-Wedeles Company's warehouse at Dearborn and North Water Streets, was handled through the tunnel. By passes of the tunnel were first run in under the proposed excavation and chutes put in from the surface down. Steel interlocking sheeting was then driven all around the sub-basement and to a depth of 50 feet which was 4 feet below the floor of the last story. Excavation was then started from the top and the mud thrown down the chutes into the tunnel cars below. As each joint of the chutes were uncovered they were removed. As each 5 feet was excavated, a set of timbers were put in as shown in Figure XXIII.

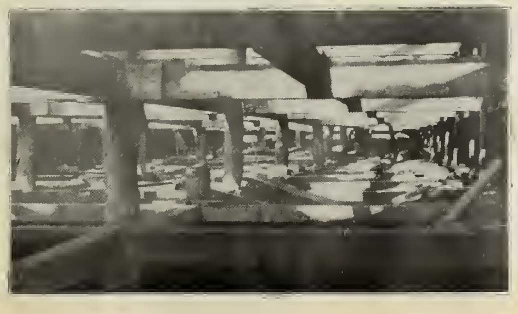


Fig XXIII

Figure XXIV shows the excavation at the bottom where the mud could be shoveled direct into the cars. It was then concreted from the bottom up.

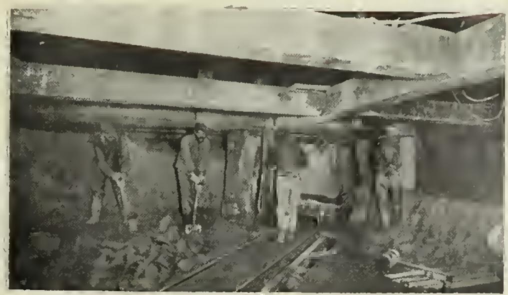


Fig XXIV

ARTICLE 3- Illinois Tunnel as connected with the future plans for a Street car subway. The tunnel is at a depth at all points which would allow for an open cut subway to be constructed above it. I might say that Mr. Jackson, in his first plans of the tunnel, saw the coming of a subway in Chicago and designed the tunnel so that it would allow for the building of a subway above it and at the same time be of great help in disposing of the excavated material from it. It can be readily seen that the subway, if it ever comes, will have to be an open cut, which is due to most all of the buildings being built on floating foundations, and that series of chutes along the street could handle the excavated material in the most satisfactory manner possible.

CHAPTER IV-SUMMARY.

ARTICLE 1- Totals. (a) The Illinois Telephone Construction Company up to September first, 1906, had constructed 239,205 feet or 45.3 miles. Since that time, George W. Jackson Inc. has constructed for the Illinois Tunnel Company, 55,800 feet or 10.57 miles,,making a total of 295,005 feet or 55.87 miles. Out of this amount of tunnel constructed 268,831 feet or 50.91 miles are under operation.

(b) There are at present 316 two-way, 98 three-way and 119 four-way intersections.

(c) There are sixty recesses in which discharge pipes are connected with city sewers and 8.24 miles of drainage pipe.

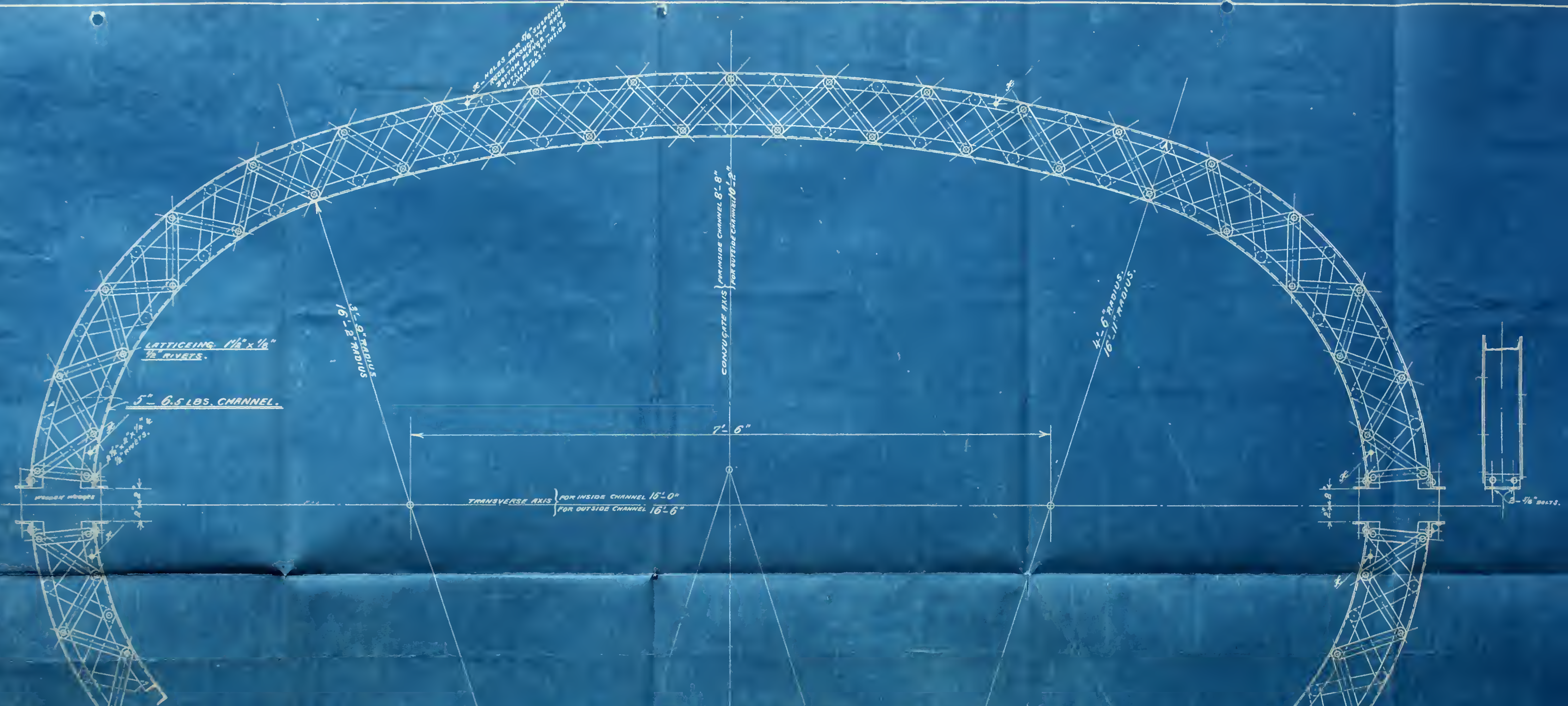
4 pumps of 50 gallon capacity each,
5 " " 75 " " "
30 " " 100 " " "
12 " " 800 " " "

giving a total of 13,175 gallons per minute.

ARTICLE 2- (a) Straight tunnel costs approximately $30.00 a foot complete; four-way intersections $1,250; and three-way intersections $800.

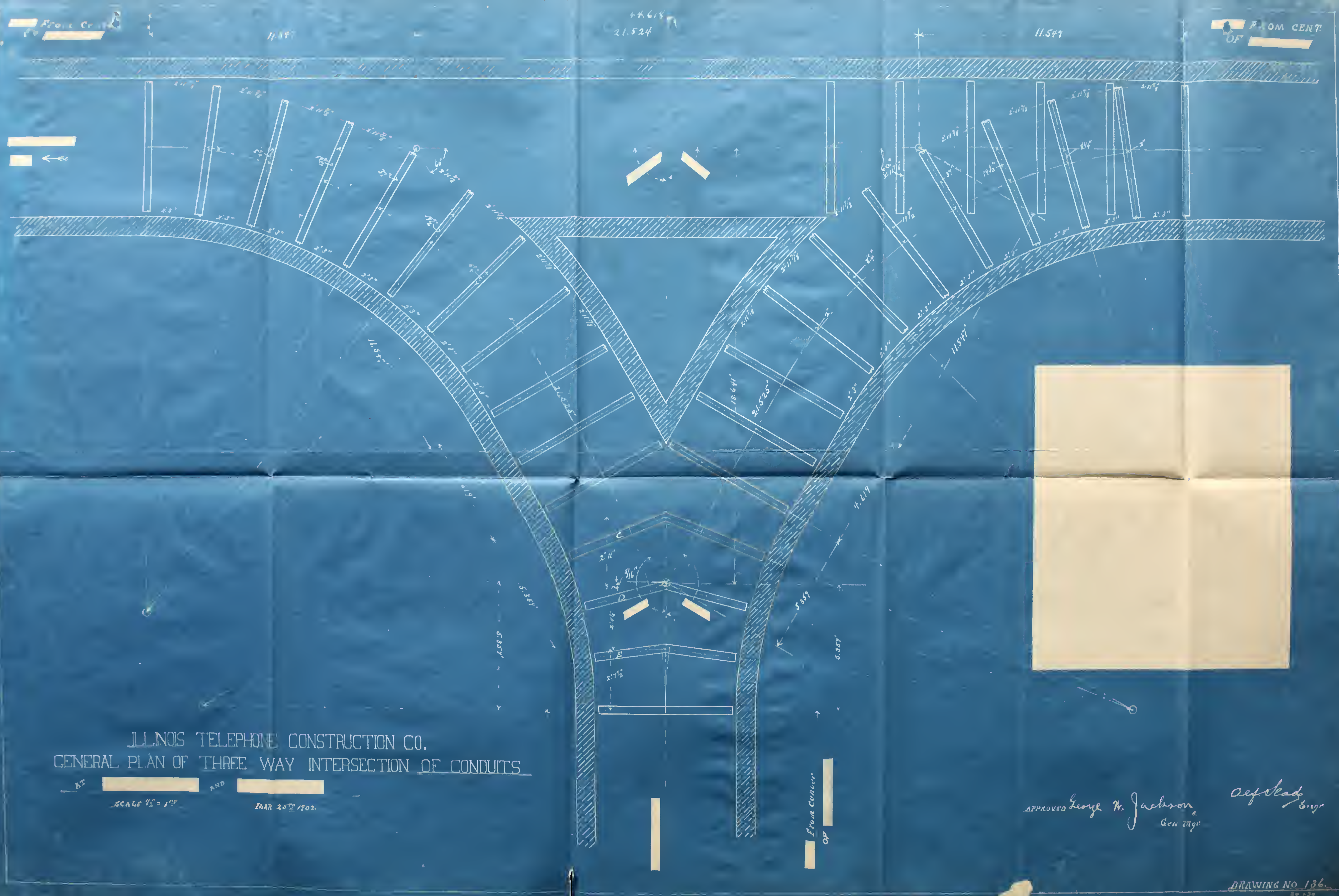
(b) There are one huudred elevator shafts, the elevators of which have a capacity of 14,000 # and a velocity of 93 feet per minute. The entire shaft and equipment costs about $7500.00.

Plate I.



SHOWING CROSS SECTION OF 8'-0" x 14'-4" SHAFT WITH EMBEDDED STEEL REENFORCEMENT.

Plate II



ILLINOIS TELEPHONE CONSTRUCTION CO.

GENERAL PLAN OF THREE WAY INTERSECTION OF CONDUITS

AT [redacted] AND [redacted]

SCALE 1/2" = 1 FT

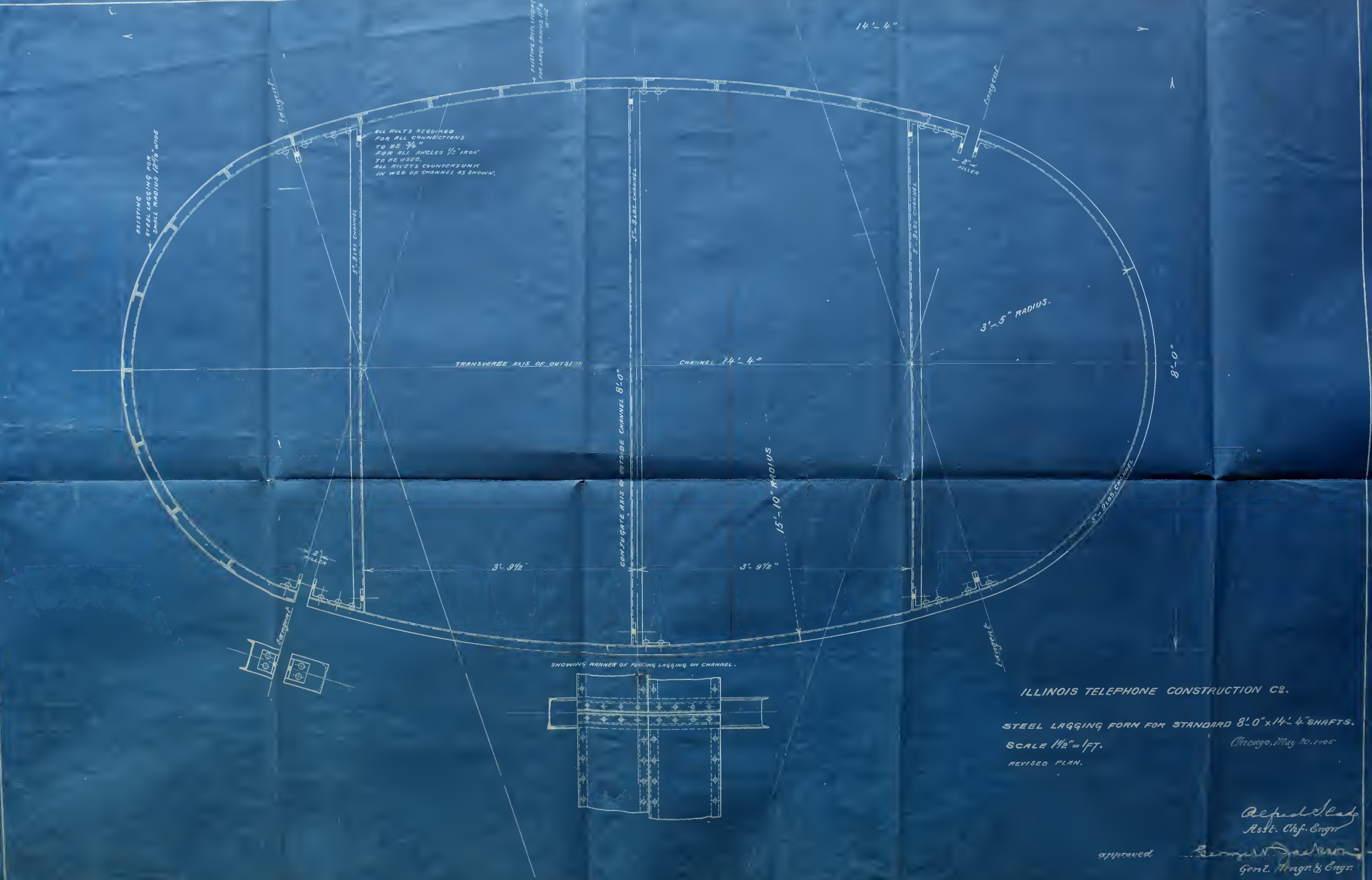
MAR 25th 1902.

APPROVED George W. Jackson
Gen Mgr

a.e.f. Sleade
Engr

DRAWING NO 136.

Plate III


14'-4"
EXISTING STEEL LAGGING FOR LARGE RADIUS 11 7/8" WIDE
tangent
tangent
EXISTING STEEL LAGGING FOR SMALL RADIUS 12 5/8" WIDE
ALL BOLTS REQUIRED FOR ALL CONNECTIONS TO BE 3/4"
FOR ALL ANGLES 1/2" IRON TO BE USED.
ALL RIVETS COUNTERSUNK IN WEB OF CHANNEL AS SHOWN.
2" FILLER
5"- 9 LBS CHANNEL
5"- 9 LBS CHANNEL
5"- 9 LBS CHANNEL
5"- 9 LBS CHANNEL
3'-5" RADIUS.
8'-0"
TRANSVERSE AXIS OF OUTSIDE CHANNEL 14'-4"
CONJUGATE AXIS OF OUTSIDE CHANNEL 8'-0"
15'-10" RADIUS
2" FILLER
3'-9 1/2"
3'-9 1/2"
tangent
tangent
SHOWING MANNER OF PLACING LAGGING ON CHANNEL.

ILLINOIS TELEPHONE CONSTRUCTION Co.

STEEL LAGGING FORM FOR STANDARD 8'-0" x 14'-4" SHAFTS.

SCALE 1 1/2" = 1 FT.

Chicago, May 20. 1905

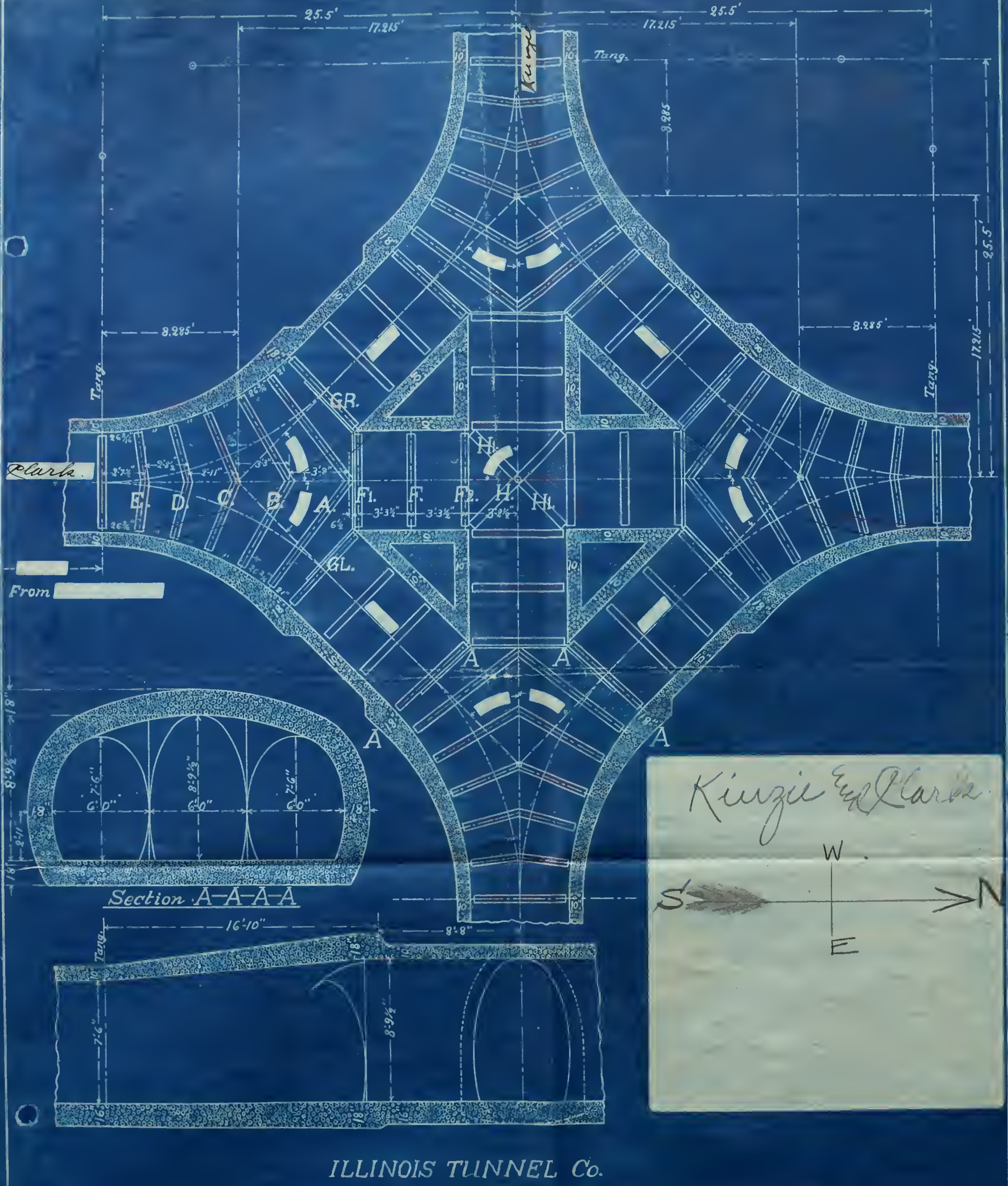
REVISED PLAN.

Alfred Slade
Asst. Chf. Engr.

approved George W. Jackson
Genl. Mngr. & Engr.

DRAWING 923.

Plate IV



ILLINOIS TUNNEL Co.

WORKING PLAN OF FOUR WAY INTERSECTION.

Scale 9/16"=1ft *March 7th 1907.*

AT

A. G. Slade
Ast. Ch. Eng

Drawing No. 1101.A.

12"x16"

UNIVERSITY OF ILLINOIS-URBANA
3 0112 079094550